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ABSTRACT

This study attempted to establish the relationship of cognitive aptitudes and styles to measures of general and more subtle academic achievement. It was expected that the associations of aptitudes and styles to general measures of achievement would converge to form similar correlational patterns; associations of aptitudes to more subtle measures of achievement would also converge, while associations of styles to subtle achievement variables would diverge. Subjects were drawn from a large-enrollment introductory geography course utilizing an auto-tutorial mastery design for college freshmen and sophomores. Relationships with the subtle achievement measures were as expected, but the associations with general achievement measures did not converge. It is suggested that future style research focus on simpler variables theoretically linked to mediational processes described in the theory of cognitive style. A list of references is provided. (Author/RAO)

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# A Comparison: Predicting College Level Academic Success With Tests of Cognitive Style and Cognitive Aptitude

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A Comparison:
Predicting College Level Academic Success
With Tests of Cognitive Style and Cognitive Aptitude

This study attempted to establish the relationship of cognitive aptitudes and styles to measures of general and more subtle academic achievement. It was expected that the associations of aptitudes and styles to two general measures of achievement would converge to form similar correlational patterns; associations of aptitudes to more subtle measures of achievement would also converge, while associations of styles to subtle achievement variables would diverge. Relationships with the subtle achievement measures were as expected, but the associations with general achievement measures did not converge. It is suggested that future style research focus on simpler variables theoretically linked to mediational process in the style literature.

## Introduction

In the systematic development of instruction, one major concern of research into individual differences has been the attempt to relate psychological theory to the prediction of college level academic success and ultimately to the effectiveness of classroom instruction. Initially such prediction was used for the purpose of selection; more recently, with the development of aptitude treatment interaction (ATI) research, aptitude measurement has been used to optimize learning for all students through differential application of instructional treatments to suit various individual differences.

The process of instructional design and development is especially concerned with this relationship of aptitudes and treatments when it deals with the development of academic courses in higher education. A variety of course designs such as lecture, recitation, Keller Plan, contract or tutorial instruction may be employed separately or in combination as the organizational framework of course format or presentation. A range of learner aptitudes such as quantitative, verbal, spatial or problem solving abilities may interact with content or course design options to facilitate the success of certain learners. For example, it has been shown that the personality variables of achievement via conformance and achievement via independence interact with certain course design factors so that students who score high on a measure of conforming motivation demonstrate higher achievement in settings which reward conforming behavior while students who score high on a measure of

independent motivation demonstrate higher achievement in course designs which reward independent behavior (Domino, 1968).

Problem

Because of the possibility of such interactions between learner characteristics and elements of course design, it is important to the field of instructional development to investigate whether achievement in a specific instructional environment (especially one with a strong technological design) correlates with academic success or whether certain learner variables are associated with achievement in specific instructional designs.

Traditionally research has examined the effects of cognitive aptitudes and personality dimensions on learning. Recently interest has grown in a new category of variables, cognitive style, described as an individual's characteristic or preferred way of perceiving and/or organizing the world (Messick, 1976; Ausburn & Ausburn, 1978). In relation to models of cognitive aptitudes and personality dimensions, cognitive styles are represented theoretically as mediating processes which cut across the somewhat arbitrary aptitude and personality categories (Messick, 1976; Royce, 1973). A number of authors have observed that this class of variables, cognitive styles, should be useful in predicting academic success (Messick, 1976; Cross, 1976; Ausburn & Ausburn, 1978). In addition, because cognitive styles characterize the way in which an individual learns rather than the what of learning, they should constitute an especially valuable variable in the study of learning in relation to variations in course designs. With theoretical relevance to both the processes and the outcomes of academic performance, cognitive style may con-

tribute to the prediction of success and/or differential behavior in a variety of learning environments.

The basic association between cognitive style and the traditional research variables of cognitive aptitudes and personality dimensions, especially as they relate to the prediction of academic success, however, is largely unexplored and, therefore, an important point of departure for research. This study approached the fundamental question: In the prediction of academic achievement, both general (Grade Point Average) and at the level of course design, do a selected class of cognitive style measures add to the variance accounted for by traditional cognitive aptitude measures? This general research question was reduced to the following more specific questions:

1. Do cognitive style measures contribute to the prediction of general academic achievement (GPA)?
2. When considered together do cognitive style measures predict general academic achievement over and above traditional cognitive aptitude measures?
3. Do cognitive style measures contribute to the prediction of academic achievement in a specific course design?
4. When considered together do cognitive style measures predict academic achievement in a specific course design over and above traditional cognitive aptitude measures?
5. What is the shared variance between style and cognitive aptitude measures in predicting academic achievement measures?
6. Do patterns of prediction variables for general academic success differ from patterns of prediction variables for academic achievement in a specific course design?

Related Research

Other than with Witkin's (1977) construct Field Dependence-Field Independence, there has been a reasonably modest amount of research examining the validity of cognitive style by academic relationships. Witkin's review of research is quite extensive; the major generalizations relevant to this study are:

1. Field Dependent students seem to attend to and learn more effectively from social cues.
2. Field Independent students are less sensitive to social punishment and they seem to learn more in the absence of external reward, under intrinsic motivating contingencies.
3. Field Independent students seem to use more mediational processes such as the analysis and restructuring of stimuli, especially in unstructured instructional environments.

The following style dimensions were included as variables in the study (see Messick (1977) or Ausburn & Ausburn (1978) for a more extensive review):

1. Field dependence-field independence is a measure of an individual's self, non-self segregation as reflected by reliance on internal versus external cues in relating self to the surrounding environment. Behaviorally, field dependence influences the extent to which an individual operates autonomously in interpersonal relations and the manner in which one processes information from the environment. The test used to measure field dependence-field independence was Witkin's Group Embedded Figures Test. It involves disembedding a simple figure from a complex pattern.

2. Closure flexibility measures an individual's ability to keep a configuration in mind in spite of distraction. There is some claim that it is a measure of temperament and that it differentiates industrial occupation groups. The test which measures closure flexibility, the Concealed Figures Test, is very similar to the Group Embedded Figures Test and has been used as a measure of field dependence-field independence.
3. Visualization and spatial relations were measured using Flags and the space relations scale of the Differential Aptitude Test. Flags involves the rotation and matching of a two dimensional design while the DAT requires mental folding of a two dimensional pattern to form a three dimensional shape.
4. Conceptual differentiation is an individual's characteristic tendency to employ relatively more or fewer distinctions between concepts in category formation on a free categorizing task. The Clayton-Jackson Object Sort, used to measure conceptual differentiation and compartmentalization, is a free categorizing task in which individuals group fifty objects into an unspecified number of categories and label the logical reason for category membership.
5. Compartmentalization reflects an individual's tendency to conceptualize objects in discrete, rigid categories. It is assumed to reflect an inability to produce diverse ideas. The measurement of compartmentalization is a count of the number of objects which an individual is unable to incorporate into categories in the Clayton-Jackson Object Sort.

6. Conceptualizing Style indicates an individual's characteristic manner of establishing criteria for category formation, either on the basis of physical, inferred or relational similarity (such as two dissimilar objects each related to a third). The measure of conceptualizing style was a panel judgment of the category reasons on the Clayton-Jackson Object Sort.

7. Leveling-sharpening refers to an individual's mode of organizing a sequence of stimuli as either relatively more or less highly articulated. The Schematizing Test consists of a series of ninety squares varying in size from one to eighteen inches. As the squares are projected on a blank screen in a darkened room, the individual is asked to judge the size of the squares in inches. A "sharpener" tends to make more distinctions between stimuli of similar but unequal size while a "leveler" tends to group similar sizes into a single category reporting unequal squares as the same.

8. Category width or equivalence range describes whether an individual tends to form broad, inclusive categories or narrow, exclusive categories. The instrument used to measure category width is the Pettigrew Category Based Width Scale. The individual is asked to estimate the largest and smallest example of an item in existence when given an indication of an average size. Broad categorizers will choose extremes while narrow categorizers will estimate closer to the average.

9. Complexity-simplicity measures the capacity of an individual

to view the environment, especially the social environment in a multidimensional way. Kelly's Role Construct Repertory Test, modified for analysis via multidimensional scaling served as the measure of complexity-simplicity. Participants were asked to rate fifteen paired roles as similar or dissimilar to each other. Complex individuals made finer distinctions between roles, using more dimensions to differentiate.

10. Constricted versus flexible control describes the extent to which an individual is able to restrict his/her attention and control susceptibility to distraction. The test which measures this style is the Speed of Color Discrimination Test. In the first part of the test participants are to identify the color of ink used to print short series of dots. The test is highly speeded; participants are given only fifty seconds to identify the color of ninety-six patterns. On the second part, instead of dot patterns, the name of a color is written in a different color ink. The individual is to identify the color of the ink. More flexible individuals are less distracted so that the difference in their scores on the two parts will be less.

## Method

The college level course from which the participants for this study were drawn was a large-enrollment introductory Geography course for freshmen and sophomores at a large mid-western university. The course design was an auto-tutorial mastery design which has been rigorously developed over a period of five years.

Instructional environments consisted of a laboratory setting in which students utilized behavioral objectives, audio tapes, various visual stimulus materials and practice tests in a typical mastery pattern. A discussion section was used for motivational exercises (e.g. educational games) and clarification of content. Previous evaluation efforts have shown (Schwen and Keller, 1977) that the treatment is quite demanding, eliciting many productive learning behaviors.

Course grades were based on three objective exams and a judged term paper. The exams were rigorously developed in the process of course development. Most items (twenty out of thirty) were of a concept learning form while the paper was a modified problem solving task.

Participants in the study consisted of 240 undergraduate students, two-thirds of whom were enrolled in the course during the process of the study and one-third of whom were a random sample of students who had taken the course in prior semesters. These groups of students were compared; there were no major differences between the two groups. This group of students has been shown in previous research to be similar to the general population of college freshmen and sophomores (Schwen and Keller, 1977).

These students were tested using conventional large group testing procedures. The group of students who had taken the course in past semesters were tested in two, three-hour evening sessions while students enrolled in the course were tested in a series of nine, forty-minute testing sessions spread over a fifteen week span. The order of tests was varied to reduce the effects of fatigue and practice as well as any interactive effects between measures. Those subjects

for whom test data was incomplete were dropped from the study.

Tests included measures of cognitive aptitude, cognitive style and academic success. SAT scores and a ratio variable of high school rank to class size were used as traditional or "markers" in cognitive aptitude predictors of academic achievement.

Cognitive style constructs were selected on the basis of factor analytic studies (Royce, 1973; Gardner, et. al., 1968). The criteria used to select the measures were that measures should be reasonably well defined and coordinate; independent of one another; capable of being administered in large groups; reasonably short; appropriate for college-aged participants and reliable.

Measures of the dependent variable, academic success, were of both a general and a course specific nature. The general measure of academic success was the students' first semester grade point average. Course specific measures of academic success included the second objective test and a term paper. The tests and processes of judging papers were developed along with the course over a five year period and reliabilities exceed traditional standards for both measures (.85 - thirty item test; .92 - inter-rater reliability on paper).

Design

This study was the first of several establishing the relationships between style and instructional outcomes. The dependent variables were selected to represent the full range of performance from complex constructs such as Grade Point Average (GPA) to concept and problem solving behaviors.

Traditional cognitive predictors of achievement were used as

"markers" or bench marks for the observed relationships. This use of traditional predictors made it possible to compare the utility and explanatory power of adding style constructs to predictors of achievement.

Some criticisms of style research have suggested these measures are confounded with general cognitive ability measures. The use of multiple stepwise regression procedures permitted a partial test of this criticism. The overlap between style and cognitive measures was examined with each prediction of a dependent measure.

Our expectations regarding the data were that the more complex composite variables, GPA and the total points in the course, would illustrate similar patterns of relationships in combination with the aptitude measures. This convergent expectation or hypothesis was based on the assumption that these variables were roughly equal in complexity and a result of the same complex processes. Also, we did not expect style measures to be highly correlated with these dependent variables. We reasoned that these variables were quite different in complexity and the theory of the style measures (Messick,1977) would suggest that the style measures are bi polar mediational processes where the same outcomes may be achieved through the different (bi polar) processes.

Our expectations regarding the more subtle course dependent variables and the cognitive styles and aptitudes were that the cognitive aptitudes were so complex that they would converge in association with the more subtle dependent variables. In other words, general academic aptitude would not differentiate between more subtle measures of academic achievement. However, we expected the style measures to diverge, or illustrate different correlational patterns, in combination with the dependent variables. Our expectation

was that the more subtle style constructs and related measures could differentiate between the subtle measures of academic success. In other words, we assumed the different dependent variables involved different mediational responses.

Data Analysis

The several multiple regression analyses are summarized in Figure 1. The amount of variance shared by the cognitive aptitudes and dependent measures is shown by the solid line joining the ✲ shape. The amount of variance shared by the style measures and dependent measures is shown by the dotted line joining the o shape. The amount of variance the style measures shared with the dependent measure after the common variance between aptitude measures and dependent measures was removed from the regression equation is shown by the dash-dot line joining the Δ shape.

The total variance shared among cognitive aptitude and style measures with the achievement measures is recorded at the bottom of the chart.

The calculation of common variance followed the SPSS format (Multiple Regression Subprogram) with adjustment for error.

The individual cognitive style measures that accounted for the greater part of the variance in each equation are indicated with a letter code immediately adjacent to each percent-of-variance data point. The problem solving variable, shown to the right on the graph, is a measure from another study we conducted. These are problems from the classical literature on problem solving. These data were incorporated to demonstrate the contrast in relationships between the more complex multivariate course related variables and the more precise univariate problem solving variable.

The most striking of the several relationships would seem to be the interaction between the complexity of the dependent variable and the amount of unique variance between style and the dependent variables. In general it would seem that the more univariant variables would be most suitable for future research with the style variables.

It should be noted that the dependent variables are not independent. Total is a composite score that includes $T_2$ (the second objective test) and the problem solving paper. The total score was utilized to compare it with GPA. As noted, the expectation was that these variables would exhibit similar relationships. This is, obviously, not the case. We have no explanation for this discrepancy. The measure is either invalid or there is a complex interaction between the rest of the variables in the composite $T_2$ and paper and the predictor variables.

The magnitude of the relationships between style and the dependent variables is modest for the course variables. Also, the overlap between style and cognitive variables could be interpreted as support for the previously noted criticism of the style measures. Our interpretation is that the theoretical definitions of these style constructs include mediational or process responses. Many of the definitions are bi polar, not necessarily implying more or less skill but <u>different</u> mediational responses. Therefore, the style by achievement validity coefficients may be expected to be modest. Dependent variables closer to the mediational processes or dependent variables that are instrumental in producing the dependent variables may produce associations of greater magnitude.

Consistent with this line of reasoning, the rather substantial associations between styles and classical problem solving items

may be seen as evidence of the confounding of cognitive spatial aptitude (DAT, Concealed Figures, etc. are sometimes described as spatial aptitudes) and style. This topic is being explored in more depth in a related study.

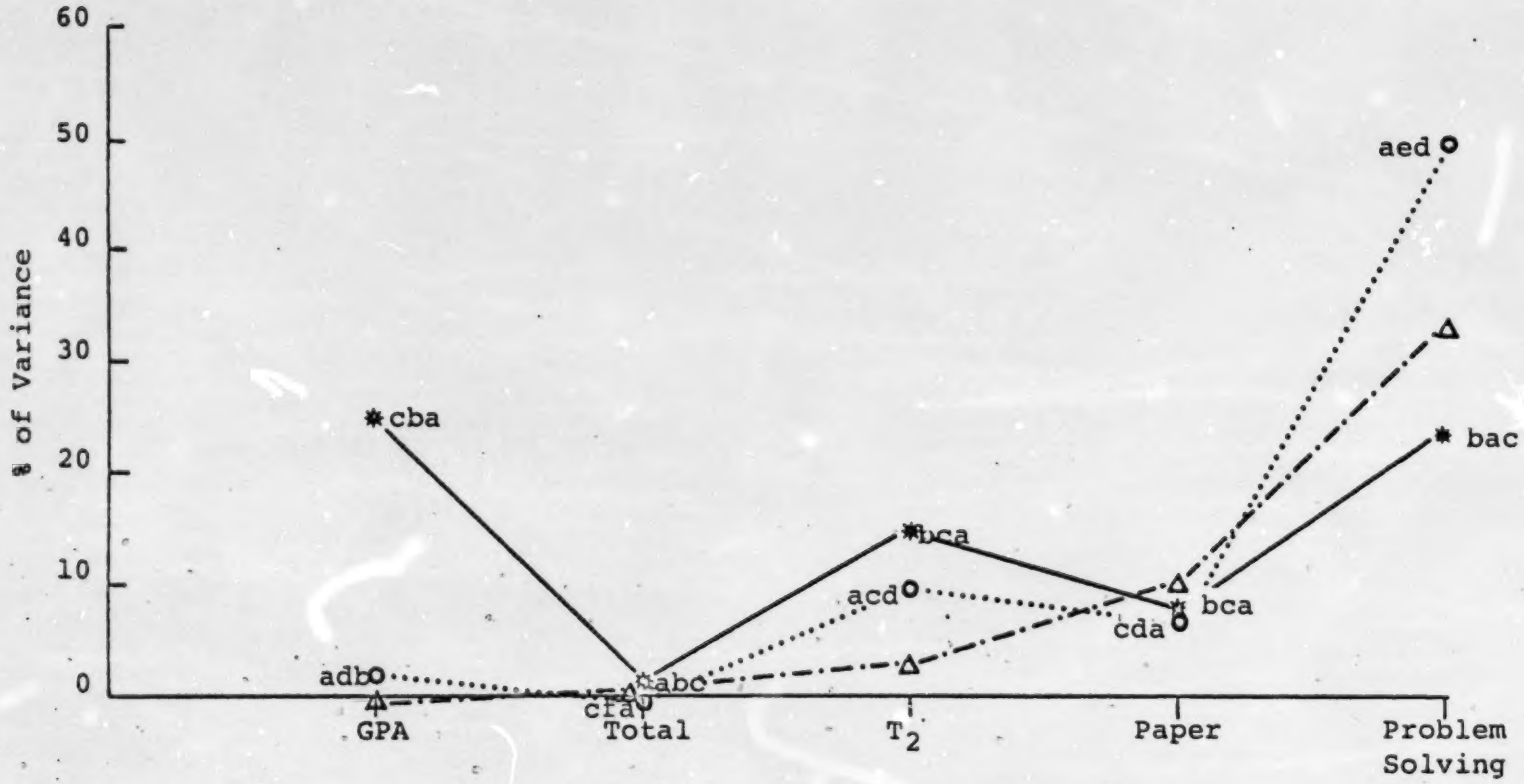
The order (in the regression equations) of the style and aptitude variables across the dependent variables is of some interest. The concept learning test two ($T_2$) and the paper seem to be drawing on the same cognitive aptitude but different style variables. This pattern is satisfying because the aptitude constructs are defined as quite gross or complex whereas the style constructs are defined as being more subtle. Also, the dependent variables should be drawing on different cognitive processes. The assumption was that the complex measures would converge and the subtle measures would diverge in association with reasonably subtle differences in dependent variables.

In summary, this study attempted to probe the validity of cognitive style by typical dependent variables in the context of a mastery oriented course. Our expectations were that the associations between complex variables GPA and total points in the course with cognitive aptitudes and styles would converge or exhibit similar correlational patterns. This was not the case, leading us to question the validity of the total measure. Our expectations regarding the more univariant dependent variables, concept learning and paper performance was that the association would converge in respect to aptitude and the dependent measures. In other words there would be similar patterns of correlation across these sets of variables. Further, our expectation was that the style by dependent measure associations would diverge. In other words there would be different patterns of correlation. These expectations were more or less confirmed

leading us to conclude the less complex style measures may be more closely linked to the concept and problem solving variables as the theory in these two areas would suggest.

The magnitude and patterns of the relationships between style and the course dependent variables led us to conclude there would be merit in continuing this kind of exploratory effort. However, our new efforts will be focused on simpler theoretical variables that are theoretically linked to the mediational processes described in the theory of cognitive style. In conjunction with our associates we are currently exploring the association between style and instrumental behaviors such as perceptual attack skills, selected discussion and problem solving behaviors.

Figure 1.
Summary Table of Multiple Regression Analyses




| | GPA | Total | $T_2$ | Paper | Problem Solving |
|---|---|---|---|---|---|
| Total Variance Accounted for by Cognitive Aptitude and Cognitive Style: | .25115 | .02296 | .19410 | .19431 | .57443 |

* = a.SAT Verbal, b.SAT Math, c.Class Rank - APTITUDES

o = a.Closure flexibility, b.Compartmentalization, c.Constricted/Flexible, d.Category Width, e.Space Relations, f.Visualization - COGNITIVE STYLES

Δ = Variance accounted for by Cognitive Style after Cognitive Aptitude

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